[0021] FIG. **15** illustrates a side view of an exemplary flexible printed circuit (FPC) stackup according to one embodiment of this invention.

[0022] FIGS. **16**a-**16**c illustrate top views of an exemplary FPC design according to one embodiment of this invention.

[0023] FIG. **17**a illustrates an exemplary partially fabricated cover for a touch screen sensor panel according to one embodiment of this invention.

[0024] FIG. **17**b illustrates an exemplary top PET film according to one embodiment of this invention.

[0025] FIG. **17**c illustrates an exemplary touch screen sensor panel stackup with columns and rows that can be formed on two separate PET films according to one embodiment of this invention.

[0026] FIG. **18** illustrates an exemplary computing system that can be operable with the touchscreen stackups according to one embodiment of this invention.

[0027] FIG. **19**a illustrates an exemplary mobile telephone that can include the touchscreen stackups and computing system according to embodiments of the invention.

[0028] FIG. **19**b illustrates an exemplary digital audio/video player that can include the touchscreen stackups and computing system according to embodiments of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0029] In the following description of preferred embodiments, reference is made to the accompanying drawings which form a part hereof, and in which it is shown by way of illustration specific embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized and structural changes may be made without departing from the scope of the preferred embodiments of the present invention.

[0030] It should be understood that in all of the figures and descriptions that follow, the listed materials, properties and dimensions (listed in units of millimeters unless otherwise noted) are merely exemplary in nature and are not intended to limit the scope of the invention.

[0031] FIGS. **1**a-**1**d illustrate various exemplary touchscreen sensor panel stackups with rows and columns that can be formed on the back side of a cover glass according to one embodiment of this invention.

[0032] FIG. **1**a shows window **1116** that can be formed in 0.8 to 1.0 polycarbonate (PC) housing **118**. Within window **116** can be a stack-up in which the row and column traces can be formed on the back side of a cover glass. Substantially transparent glass subassembly **100** can have a front or top side capable of sensing when the user touches the window above it, and a back side opposite the front side. Glass subassembly **100** can have a stackup of layers that can include, in order from top to bottom, substantially transparent anti-glare (AG) coating **113** (shown as a dashed line at the top of the subassembly) (or this can be anti-reflective (AR) coating, or just plain glass or plastic surface of the window), substantially transparent 0.7 borosilicate or aluminum silicate glass, black mask (in limited areas), substantially transparent conductive material such as patterned Indium Tin Oxide (ITO) (15 to 200 ohms per square max, with 0.3 lines and 0.030 spaces) formed as columns, a substantially transparent 0.025 dielectric layer (e.g. sol-gel TIO2) with vias, and another layer of substantially transparent conductive material such as patterned ITO (15 to 200 ohm max, with 0.3 lines and 0.030 spaces) formed as rows. The two layers of patterned substantially transparent conductive material can be of the same or different composition. The black mask (or a mask of any color) can be used to hide the electrical interconnect such as metal traces located in the border areas of the touchscreen. The dielectric layer can be used as a planarization layer to enable the one layer of patterned ITO to be formed on top of another. Note that these patterned ITO layers and the dielectric layer in between are symbolically illustrated in FIG. **1**a as a dashed line representing patterning **102**.

[0033] Substantially transparent PET subassembly **106** can be bonded to glass subassembly **100** using pressure sensitive adhesive (PSA) **108**. One purpose of PET subassembly **106** can be to support a 0.188 continuous sheet of ITO (500 ohm max) that can be formed on the bottom of the PET film which can be used to shield the glass subassembly from LCD **110**, and also to provide a low capacitive spacing between the shield layer of ITO and the rows and columns. Together, glass subassembly **100** through PET film subassembly **100**, and any intervening layers, can form the touchscreen.

[0034] Flexible printed circuit (FPC) **104** can be bonded using anisotropic conductive film (ACF) (0.003 after bonding) to the back side of glass subassembly **100**. Conductive tape **112** can be used to ground the ITO formed on the bottom of the PET subassembly **106**. Substantially transparent PSA **114** of 0.125 thickness can be used to bond PET film subassembly **106** to the LCD module, which can include a 0.2 polarizer layer **115** and liquid crystals **117**. The complete assembly can then be mounted into window **116** in housing **118**. Note that when the complete assembly is mounted in housing **118**, glass subassembly **100** can be either even with or slightly recessed (0.3 Z step) from the top of the window.

[0035] FIG. **1**b is similar to FIG. **1**a, except that PET film subassembly **106** is not fully laminated to LCD module **110**. Instead, air gap **120** can be formed between them, and a ring of Poron **122** can be formed around the perimeter of the touchscreen. The air gap can allow for easier separation of the touchscreen from the LCD module in case repair, replacement or upgrading is needed. Anti-reflective (AR) coating can be applied to one or both surfaces adjacent to the air-gap to minimize reflections and associated contrast ratio degradation.

[0036] FIG. **1**c is similar to FIG. **1**b in that it includes air gap **120**, but it can be mounted into an enclosure having overhanging bezel **124**. This can be less expensive because bezel **124** can hide electrical interconnect formed in the border areas of the touchscreen, which can eliminate the need for blackmask. In addition, it can be less expensive because the housing can cover the edges of the touchglass, eliminating the need for grinding and polishing steps. Glass subassembly **132** can be identical to glass subassembly **100** in FIG. **1**.

[0037] FIG. **1**d is a hybrid of FIGS. **1**a and **1**c, wherein overhanging bezel **124** can allow the blackmask step to be eliminated, and full lamination can be used (see full layer of PSA **108**). Note that full lamination can result in a mechanically stiffer and stronger stackup, but the benefit of having an air gap is that it can make the parts separable and replaceable.

[0038] FIGS. **2**a-**2**d illustrate various exemplary touch screen sensor panel stackups with columns that can be formed on the back side of a cover glass and rows that can be formed on the bottom side of a separate PET film according to one embodiment of this invention.

[0039] FIG. **2**a shows window **216** that can be formed in 0.8 to 1.0 PC housing **218**. Within window **216** can be a stack-up